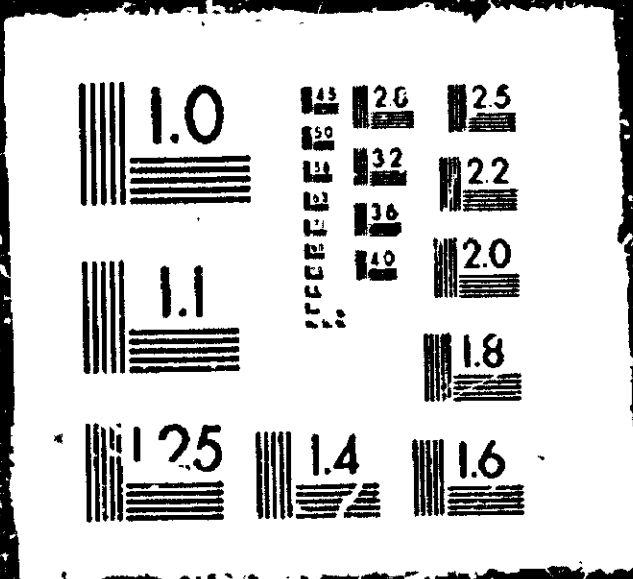


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**Special Investigation Report - Derailments of
New York City Transit Authority Trains
Involving Traction Motor Mount Failures**

**(U.S.) National Transportation Safety Board
Washington, DC**

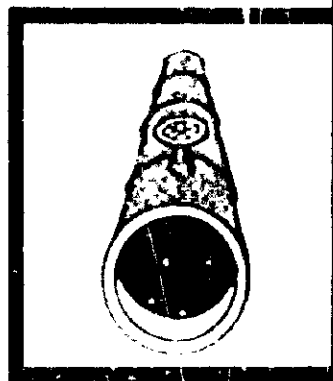
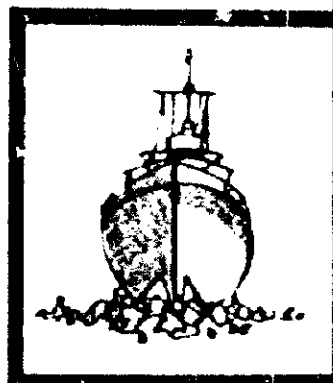
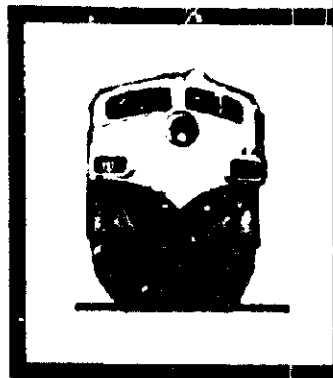
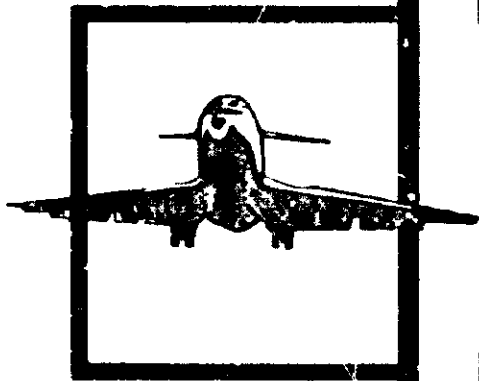
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NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SPECIAL INVESTIGATION REPORT

**DERAILMENTS OF NEW YORK CITY
TRANSIT AUTHORITY TRAINS INVOLVING
TRACTION MOTOR MOUNT FAILURES**

NTSB-TSR-SIR-82-2

UNITED STATES GOVERNMENT

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<p>16. Abstract At 5:50 a.m., on December 15, 1981, a nine-car New York City Transit Authority (NYCTA) southbound No. 3 subway train, designated 527A 148/PA, departed on track No. 2 after making a station stop at Times Square Station in New York City, New York. Moments later, while the train was accelerating, a traction motor fell from under the third car. The third car derailed and caused the fourth car to derail also. As the fourth car derailed, it turned away from the track structure and its front end struck the steel posts separating tracks Nos. 1 and 2. The rear of the car then struck the concrete curtain wall that separated track No. 2 and track M. Twelve passengers were injured and damage was estimated to be \$287,000.</p> <p>Three other derailments involving a traction motor falling from an NYCTA car to the tracks occurred between January 12, 1981, and March 7, 1982. The derailment of December 15, 1981, in which 12 passengers were injured, was the most severe of the four derailments; however, because of the Safety Board's concern that four similar derailments should occur within 15 months, and its continued concern about inspection and maintenance practices of the NYCTA, all four derailments were investigated and are discussed in this report.</p> <p>The National Transportation Safety Board determines that the probable cause of each of the four derailments was the failure of the inspection procedures of the New York City Transit Authority to detect that the traction motor mounts had failed and that the motors were riding on axles before they dropped to the tracks. Contributing to the accidents was the failure of the New York City Transit Authority to take prompt action to detect, analyze, and correct the cause of the motor mount failures.</p>					
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**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

SPECIAL INVESTIGATION REPORT

Adopted: July 15, 1982

**DERAILMENTS OF
NEW YORK CITY TRANSIT AUTHORITY TRAINS
INVOLVING TRACTION MOTOR MOUNT FAILURES**

SYNOPSIS

At 5:50 a.m., on December 15, 1981, a nine-car New York City Transit Authority (NYCTA) southbound No. 3 subway train, designated 527A 148/PA, departed on track No. 2 after making a station stop at Times Square Station in New York City, New York. Moments later, while the train was accelerating, a traction motor fell from under the third car. The third car derailed and caused the fourth car to derail also. As the fourth car derailed, it turned away from the track structure and its front end struck the steel posts separating tracks Nos. 1 and 2. The rear of the car then struck the concrete curtain wall that separated track No. 2 and track M. Twelve passengers were injured and damage was estimated to be \$287,000.

Three other derailments involving a traction motor falling from an NYCTA car to the tracks occurred between January 12, 1981, and March 7, 1982. The derailment of December 15, 1981, in which 12 passengers were injured, was the most severe of the four derailments; however, because of the Safety Board's concern that four similar derailments should occur within 15 months, and its continued concern about inspection and maintenance practices of the NYCTA, all four derailments were investigated and are discussed in this report.

The National Transportation Safety Board determines that the probable cause of each of the four derailments was the failure of the inspection procedures of the New York City Transit Authority to detect that the traction motor mounts had failed and that the motors were riding on axles before they dropped to the tracks. Contributing to the accidents was the failure of the New York City Transit Authority to take prompt action to detect, analyze, and correct the cause of the motor mount failures.

INVESTIGATION

The Accidents

On January 12, 1981, at 12:08 a.m., an eight-car NYCTA subway train, designated STL/205 11:58, 1/ was approaching Kings Highway Station, Brooklyn, at about 30 mph when a traction motor dropped to the tracks from under the third car. The truck came out from under the third car and derailed the fourth car. When the fourth car derailed, it turned crossways in the track and came to rest leaning at a 45° angle. (See figure 1.) At 12:19 a.m., the New York City Fire Department was called to assist in evacuating the passengers. The fire department arrived at 12:30 a.m., and the passengers were

1/ Indicates train was en route from Stillwell Avenue, Brooklyn, to 205th Street, Bronx, and had departed at 11:58 p.m.

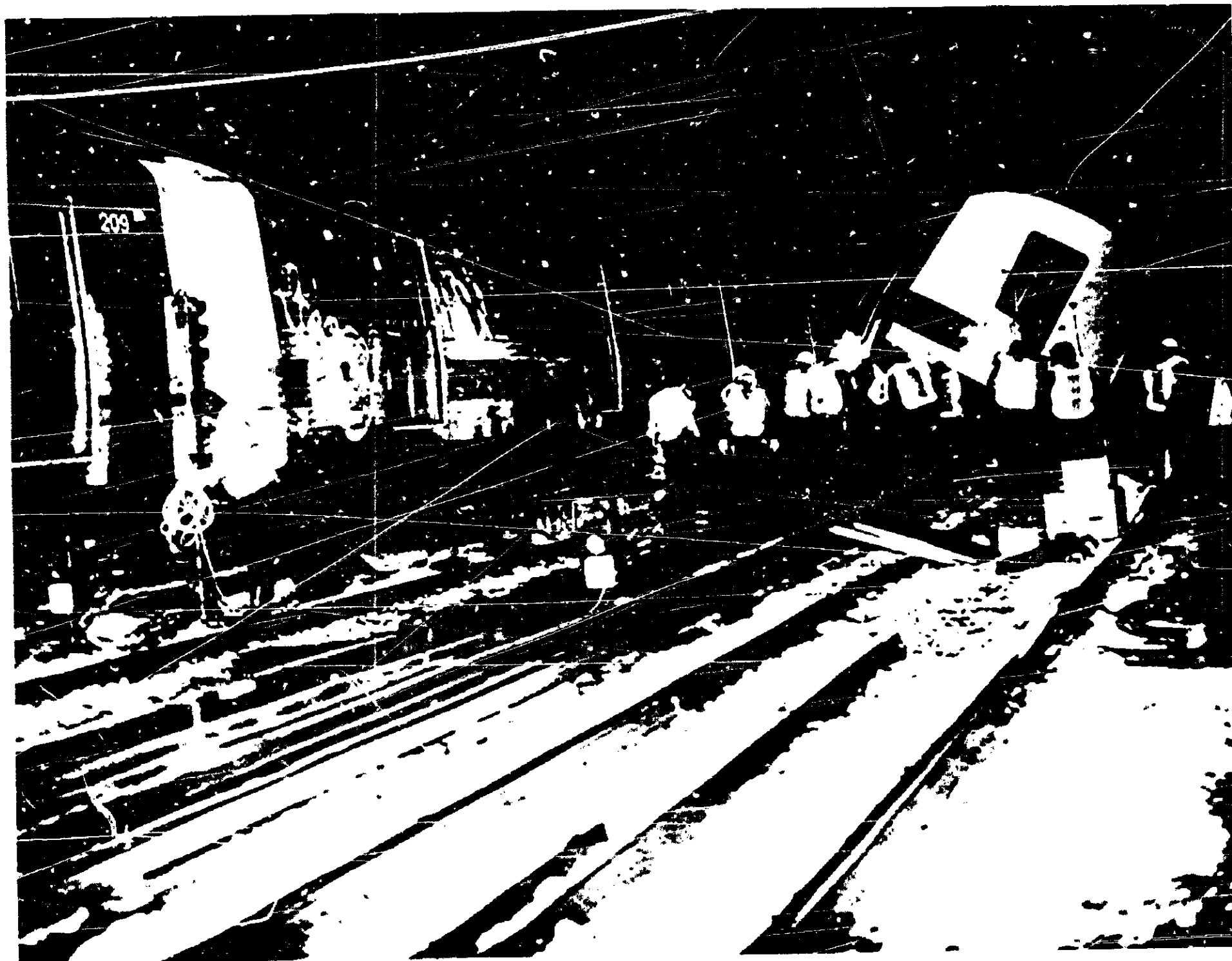


Figure 1.- -Derailment of NYCTA subway train on January 12, 1981.

evacuated along the track to the Kings Highway Station. The fire department departed at 1:13 a.m. after all passengers, including three injured persons, had been evacuated. Damage was estimated to be \$129,000.

On June 8, 1981, at 2:33 a.m., a 10-car NYCTA subway train, designated DYRE/A 217, 2/ was crossing from track No. 2 to track M as it approached the East 180th Street Station, Bronx, when a traction motor fell from the last car, No. 8724, and derailed the car in the switch of the crossover. The train continued for 30 feet after the car derailed until the brake pipe separated and the train brakes applied in emergency. There were no injuries and the passengers were discharged from the train through the first and second cars, which were in the station. Damage was estimated to be \$120,000.

Car No. 8724 had been reported as defective the day before. At 8:19 p.m., on June 7, 1981, while the car was in service in a 10-car train and while in the Atlantic Avenue Station, the train motorman reported to the NYCTA command center that smoke was issuing from his train. The passengers onboard were discharged, and the train was moved to the New Lots Yard (Livonia Inspection Barn), Brooklyn. When the train arrived at the New Lots Yard about 9 p.m., it was placed in the yard on track No. 57 because there was no room in the inspection barn. The assistant supervisor of the inspection barn noted in the trouble book: the car number, "8724;" under code of component causing defect, "S/1 smoke issuing and noise;" under defect and action taken, "D/M [dead/motor] no indication of S.I.;" and in the border area the word "hold." He then contacted the yardmaster and notified him what cars were to be held. He also sent a list to the yardmaster, but before the list was delivered, the train was dispatched into service with car No. 8724. On the morning of June 8, 1981, shortly after midnight, a train trouble team was sent into the yard to check the train. They could not find it, and noted on the hold-order report sheet, "not in yard." No further search was made to locate the car, and at 2:33 p.m., the traction motor fell from the car and the derailment occurred.

On December 15, 1981, a nine-car NYCTA subway train, designated 527A 148/FA, departed Lenox Terminal, 148th Street, Manhattan, on time. As the southbound train made its scheduled station stops, the motorman was operating the train from the operating cab of the first car and the conductor was alternating between the fourth and fifth cars, opening and closing doors at the station stops. The motorman and conductor did not take any exception to any of the cars or the manner in which the train was operating after leaving Lenox Terminal.

A regular scheduled station stop was made at the Times Square Station, and after discharging and receiving passengers, the conductor closed the doors in preparation for departure. There were approximately 100 passengers onboard the train. When the motorman received the indication to proceed, he released the brakes and applied power, and the train began to move out of the station on track No. 2. Moments later, when the head end of the train was approximately 300 feet south of the station and moving about 25 mph, the motorman felt what he described as a "serious pulling along with a bumpy feeling" in his train, followed immediately by an emergency application of the train brakes and a power failure. The motorman could not contact the command center with the onboard radio, so he went to a phone on the tunnel wall and reported at 5:50 a.m. that his train brakes had applied in emergency, and he requested supervisory assistance. Simultaneous with the motorman's report, the power system operator reported to the command center that the power was out on tracks Nos. 2 and 3. The motorman then went back to inspect his train to determine what had happened.

2/ Indicates train had departed Dyre Avenue Station, Bronx, at 2:17 p.m., for Atlantic Avenue, Brooklyn.

A traction motor had fallen from under the third car, derailed the rear truck, and derailed the fourth car. The fourth car was turned away from the track structure with the front of the car between tracks Nos. 1 and 2 and had struck the steel posts between the tracks. The rear of the fourth car was between track No. 2 and track M and had struck the curtain wall separating those tracks. (See figure 2.)

At 5:55 a.m., a motorman instructor (a supervisor) arrived at the train and found that the third and fourth cars had derailed and that there were passengers with injuries onboard the train. He reported the situation to the command center and requested medical assistance. The command center notified New York City's Emergency Medical Service at 5:56 a.m. The last two cars and half of the third car were next to the Times Square Station platform, so the conductor at 5:58 a.m. discharged the passengers from the last five cars through these cars and onto the station platform. Because the fourth car was turned and the car end doors were not aligned with the other cars, passengers could not move through this car or from this car to the rear cars. The command center notified the fire department of the accident at 6:02 a.m. and requested assistance in evacuation of passengers and removal of the injured. At 6:18 a.m., the fire department arrived at the cars and began the evacuation. All injured persons and passengers were evacuated by 6:48 a.m. Of the 12 injured passengers taken to the hospital, 5 were admitted and 7 were treated and released. Damage was estimated to be \$287,030.

On March 7, 1982, at 3:26 p.m. a 10-car NYCTA subway train, designated UA/WP254, 3/ had departed the Brooklyn Bridge Station on track No. 3 when a traction motor fell from the first car in the train and derailed the first and second cars in the train. A rescue train was dispatched from Grand Central Station at 3:58 p.m., and arrived alongside the derailed train at 4:05 p.m. The 96 passengers on the derailed train were evacuated to the rescue train between 4:10 p.m. and 4:14 p.m. Two passengers were treated for minor injuries and released. Damage was estimated to be \$115,000.

Injuries to Persons in all Four Derailments

<u>Injuries</u>	<u>Passengers</u>	<u>NYCTA Employees</u>
Fatal	0	0
Nonfatal	17	0
None	396	8
Total	413	8

Damage

In the December 15, 1981, derailment, steel columns and a steel and concrete curtain wall adjacent to the tracks were extensively damaged when they were struck by the derailed car. Nine steel columns between tracks Nos. 1 and 2 were displaced, and some of the columns were twisted. Ten feet of the curtain wall between track No. 2 and track M was demolished, including three steel columns and the 6-inch-thick concrete wall between the columns. (See figure 3.)

Car damage in the December 15, 1981, derailment was confined to the two derailed cars (the third and fourth cars). The car body bolster of the third car was bent and the car floor buckled. The group switch box under the car floor was destroyed. The roof

3/ Indicates the train departed Utica Avenue Station, Brooklyn, at 2:54 p.m., for White Plains Road, Bronx.

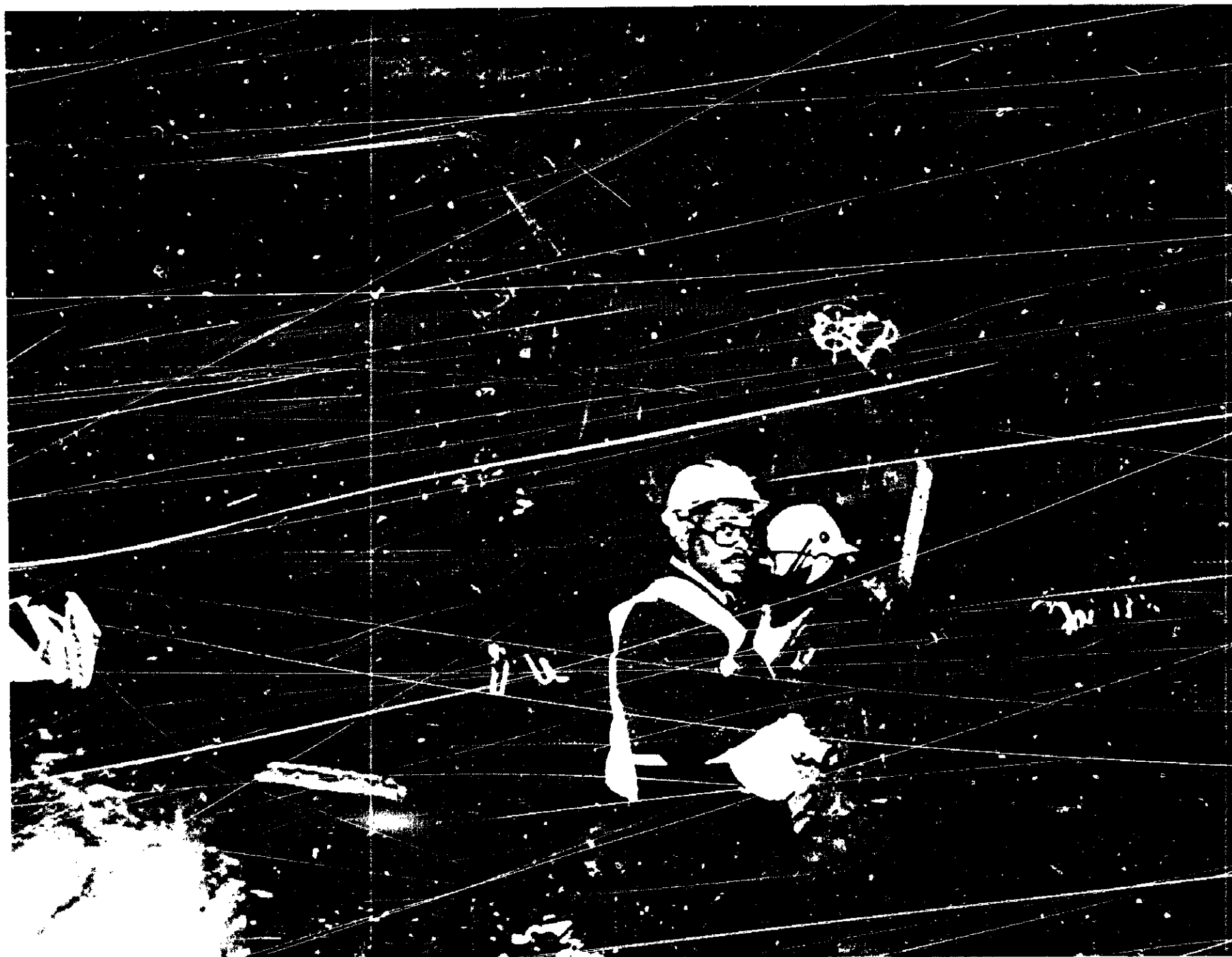


Figure 2.--Derailment of NYCTA subway train on December 15, 1981.

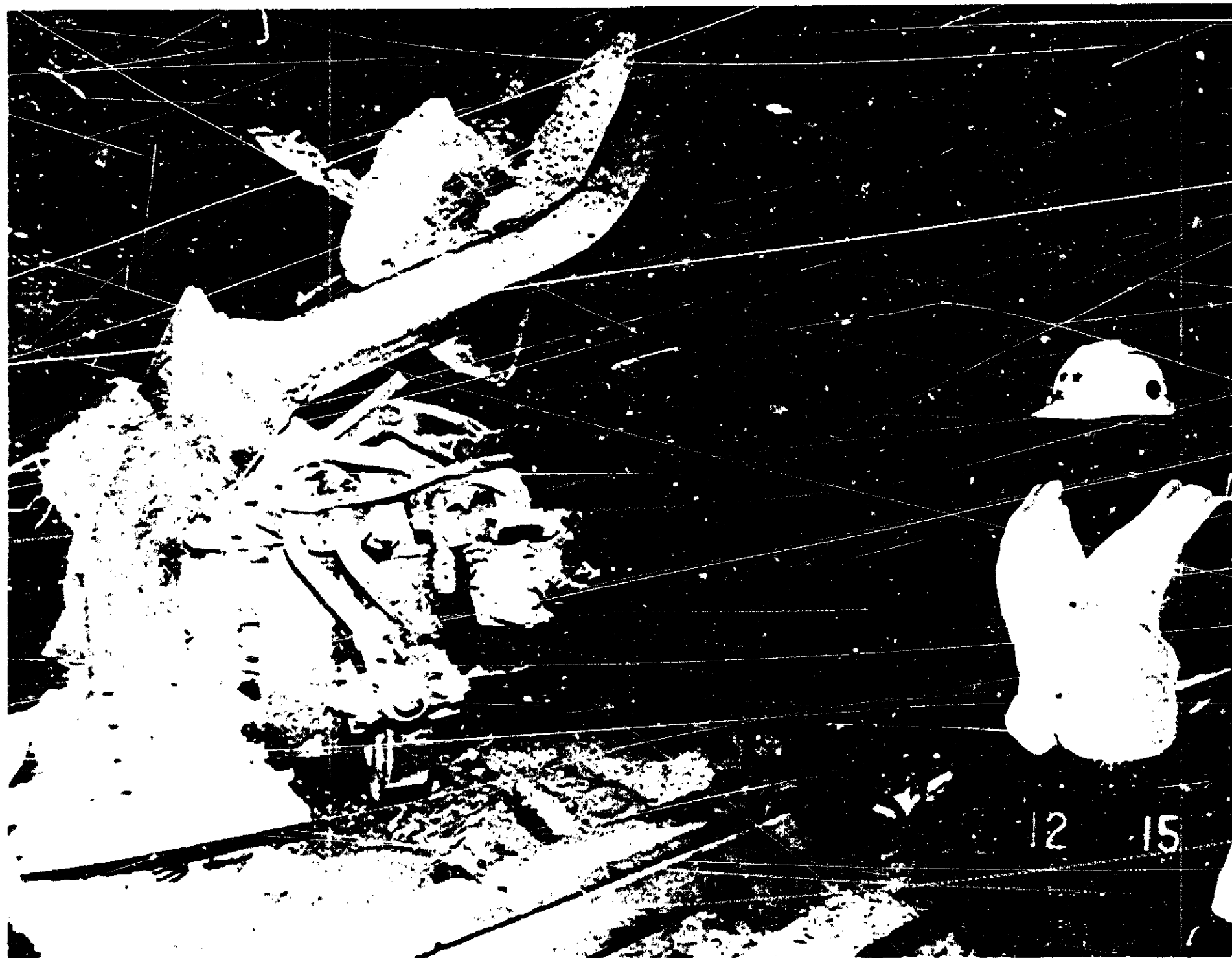


Figure 3.--Damage to steel and concrete curtain wall in tunnel involved in the December 15, 1981, derailment.

on the leading end of the car was smashed. The car's No. 2 traction motor was missing, the motor mounts were broken, and the No. 2 axle had wear marks from rubbing of the safety lugs and motor housing of the traction motor. On the fourth car, the group switch boxes were destroyed, all underfloor equipment was torn off, the car body bolsters were bent, and the roof was crushed inward. The fifth car in the train was damaged slightly when it was struck on the corner as the fourth car turned away from the track after it derailed.

In each of the other derailments, none of the cars struck tunnel structures, but the damage to the equipment below the floors of the cars was similar. Trucks were displaced and the equipment was smashed and displaced. In each of the derailments, the first car to derail had a traction motor assembly missing, the motor mounts were broken, and the axle adjacent to the location of the missing motor had wear marks where the safety lugs and motor housing of the traction motor had rubbed against it.

Damage costs were estimated as follows:

	Date of derailment				
	<u>1/12/81</u>	<u>6/8/81</u>	<u>12/15/81</u>	<u>3/7/82</u>	<u>Total</u>
Train equipment	\$100,000	\$100,000	\$207,895	\$100,000	\$507,895
Signals and power	25,000	15,000	15,000	12,000	67,000
Track	4,000	5,000	4,000	3,000	16,000
Structure			60,135		60,135
	<u>\$129,000</u>	<u>\$120,000</u>	<u>\$287,030</u>	<u>\$115,000</u>	<u>\$651,030</u>

Train Information

Three of the cars from which the traction motors fell were similar in design. (See figure 4.) The R21 type car involved in the accident on December 15, 1981, was built by the St. Louis Car Company and was put into service in 1956/57. The R29 type car involved in the accident on June 8, 1981, was built by the St. Louis Car Company and was put into service in 1962. The R28 type car involved in the accident on March 7, 1982, was built by the Amcar Division of ACF Industries and was put into service in 1960/61. These cars are 51 feet 1/2 inch long over the antilimbers and 8 feet 9 1/2 inches wide. Four 100-horsepower electric traction motors power the cars through reduction gear boxes pressed onto each axle. Each car is equipped with 44 seats and has a maximum passenger capacity of 200 persons. The car body and framing are constructed of low-alloy, high-tensile steel. The cars are equipped with dynamic and electric pneumatic braking systems. Each car is equipped with a two-way radio, a public address system, and emergency lights; all of this equipment is connected to a 32-volt battery system in the event of loss of power from the third rail.

The car involved in the accident on January 12, 1981, was an R44 type built by the St. Louis Car Company and placed in service in 1971/72. The R44 type car is 74 feet 8 1/2 inches long over the antilimbers and 10 feet wide. The car has 72 seats and a maximum passenger capacity of 350 persons. The system components such as braking, radio, public address system, and emergency lights are the same as those on the cars involved in the other accidents, except that R-44 type cars are equipped with four 115-horsepower electric traction motors.

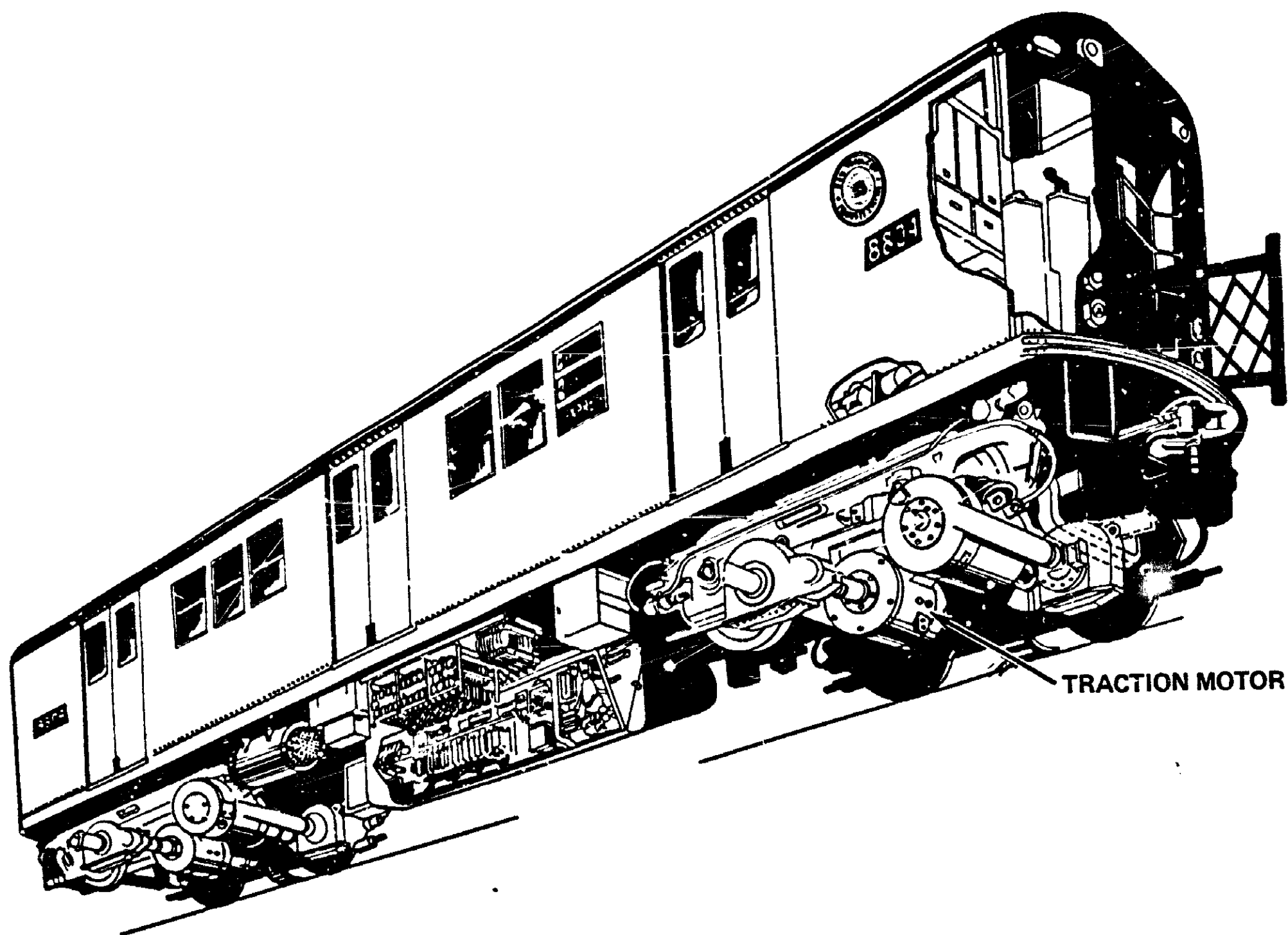


Figure 4.--Diagram of NYCTA subway car
from which traction motor fell on December 15, 1981.

Each of the traction motors on all the cars involved in the four accidents was mounted by a nose mount on the upper portion of the motor frame and a foot mount on the lower portion of the motor frame. (See figure 5.) The nose mount is a weldment and is welded to and cantilevered from the motor frame. When mounted, the motor assembly rests on and is bolted to a mating support on the top of the truck transom. A removable key is used for motor alignment. The foot mount is a contoured steel block welded to the motor frame and bolted to a mating support on the bottom of the truck transom. To prevent a free traction motor from dropping to the track in the event of a failure of both mounts, two safety nose lugs are welded on the outside of the motor frame. Continued in-service operation of a car after the traction motor mounts fail allows the fixed safety nose lugs to ride on the rotating axle; the ensuing wear will grind off the safety nose lugs and motor case, allowing the motor to drop from the train.

Method of Operation

Subway trains of the NYCTA are operated by signal indications of an automatic block signal system. The signals are time controlled to govern the speed of the train through a block territory at a predetermined speed. Trains exceeding such speed are automatically stopped.

The motormen are required to perform a preservice inspection daily if the equipment is dispatched from a shop, inspection barn, or yard. If the equipment remains in service over a 24-hour period, the daily inspection will be deferred and a comparable inspection is not performed. The preservice inspection includes a check of the running system (truck sides and brake beams and shoes) and operating system (brakes, lights, and operating compartment controls) but does not require an inspection of the traction motor.

In addition to the preservice inspection by the motormen, the NYCTA advised the Safety Board in a letter dated April 12, 1982, that "as of July 1981 the NYCTA instituted a preservice inspection program ^{4/} that utilizes an additional force of 175 road car inspectors and 15 foremen. All trains required for morning service are scheduled for a preservice examination prior to leaving storage locations, thereby permitting detection and repair of a potential problem."

An "A" inspection is required every 5,000 operating miles and is performed by shop and inspection personnel at an inspection barn or yard. An A inspection consists of a check of the batteries, compressor, motor generator, air conditioning, fans and heaters, and wheels. (See appendix B.)

A "B" inspection is required every 10,000 operating miles and is accomplished by shop and inspection personnel at a car shop. A B inspection is a comprehensive inspection of the entire car that includes the traction motor and traction motor mounts. (See appendix C.)

A "C" inspection is required every 30,000 operating miles and is performed by shop and inspection personnel at a car shop. The C inspection is more extensive than a B inspection. (See appendix C.)

Following the derailment of December 15, 1981, the NYCTA advised the Safety Board that it had instituted a special one-time inspection of the traction motors and mounts on each car in the system. On February 4, 1982, the NYCTA reported to the Safety Board that the inspection of the 2,598 cars of the Division A (the former

^{4/} An inspection for defects that can be observed walking alongside the car.

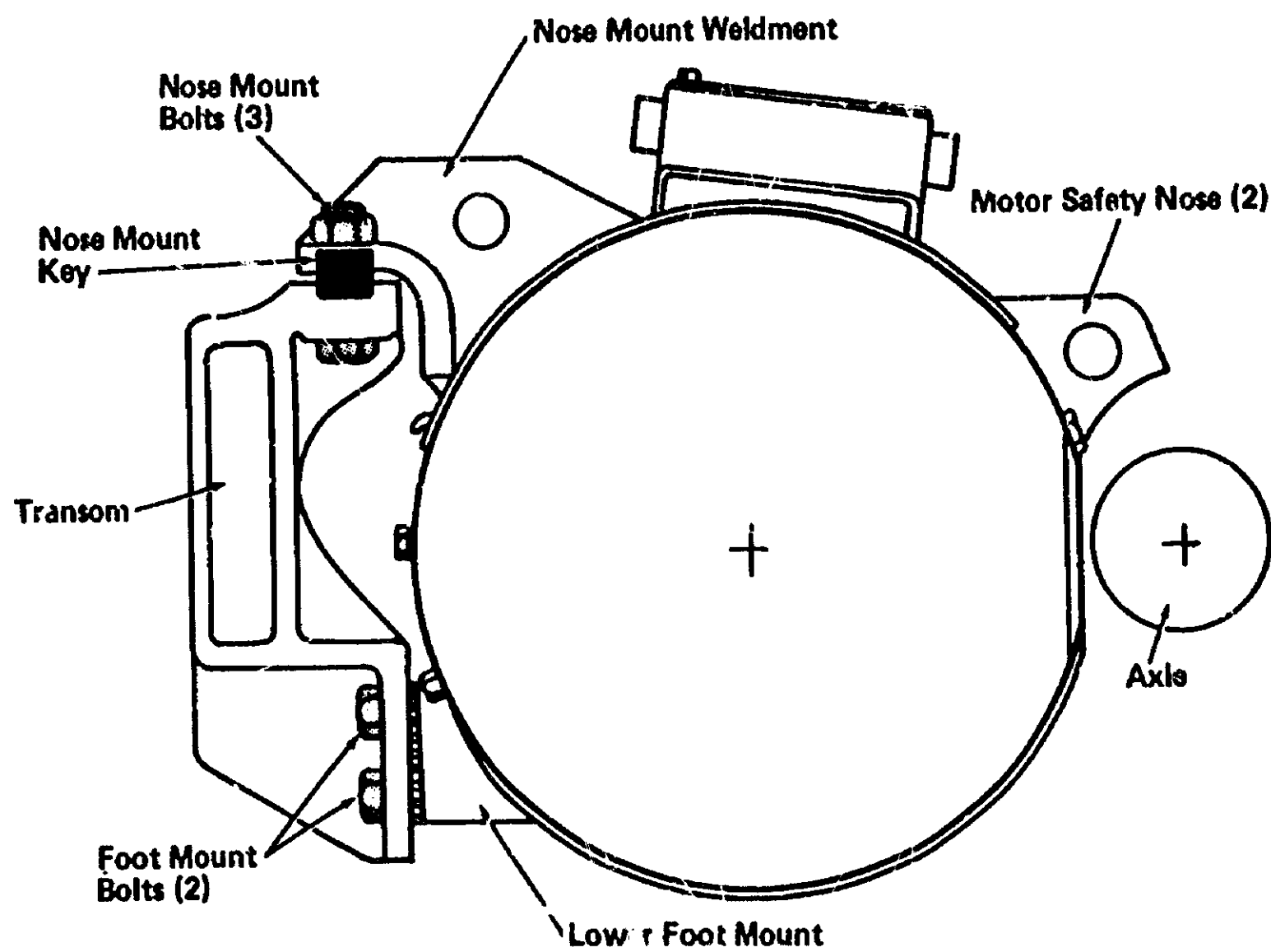


Figure 5.--Traction motor mounts on the cars involved in each derailment.

Interborough Rapid Transit Line) had been completed, and that the Southern Division had inspected 3,670 cars and the program was 80 percent completed. The total of all NYCTA cars inspected at that time was 5,534 of a total 6,268, or 88 percent of the total car fleet. During this inspection, the traction motor mounts were found broken on two cars, and the traction motors were lying on the axles of the cars and were prevented from falling to the track only by the safety nose lugs.

Medical and Pathological Information

Injuries to the passengers in the December 15, 1981, derailment included contusions and abrasions of arms, legs, back, and shoulders. One person sustained a fractured hip, ribs, and knee cap. All of the 12 injured passengers were taken to Bellevue Hospital. In the accident of January 12, 1981, three passengers sustained minor abrasions, and they were treated at the accident site. There were no injuries in the accidents of June 8, 1981, and March 7, 1982.

Survival Aspects

The December 15, 1981, derailment occurred at 5:50 a.m. As the cars derailed, the fourth car turned away from the track and the car end doors were not aligned with the adjacent cars. The last two cars and part of another car of the train were still alongside the Times Square Station platform when the train came to a stop. At 5:55 a.m., a motorman instructor reported injuries onboard the train, and at 5:56 a.m. the command center notified the New York City Emergency Medical Service. At 5:58 a.m., the passengers in the fifth through ninth cars were discharged through the end cars onto the Times Square Station platform. At 6:02 a.m., the command center notified the New York City Fire Department, and at 6:18 a.m. fire department personnel arrived at the cars and began to evacuate the passengers and remove the 12 injured passengers from the first four cars. It was necessary to take the passengers and injured through the doors and down to the track level and have them walk to the Times Square Station, a distance of about 200 feet. At 6:48 a.m. all passengers had been evacuated.

The January 12, 1981, derailment occurred at 12:08 a.m. on an elevated portion of track. At 12:19 a.m., an off-duty transit employee riding the train telephoned the command center and reported the circumstances of the derailment and the command center called the New York City Fire Department. Rescue personnel arrived at 12:30 a.m. and began to assist in evacuating passengers. The passengers were evacuated through the end doors of the cars to the track level and were escorted 500 feet to the Kings Highway Station. At 1:13 a.m., fire department personnel and passengers were off the track structure and in the station. At 1:40 a.m., the emergency medical service reported that three passengers had been treated for minor injuries at the scene.

The June 8, 1981, derailment occurred at 2:33 p.m. When the train stopped following the derailment, the two lead cars were alongside the 180th Street Station platform. All passengers were discharged through the two lead cars onto the station platform. All passengers had been discharged by 2:43 p.m.

The March 7, 1982, derailment occurred at 3:26 p.m. The assistant for operations arrived at 3:37 p.m. and a trainmaster arrived at the accident site at 3:38 p.m. Together they agreed at 3:48 p.m. that a rescue train would be used to remove the passengers from the derailed train. At 3:54 p.m., the motorman of an in-service train was instructed by the command center to discharge passengers at the Grand Central Station, pick up

stages, 5/ and proceed to the derailment site. The rescue train departed Grand Central Station at 3:58 p.m., and at 4:05 p.m. was positioned on the track next to the derailed train. At 4:10 p.m., after the stages were in place, the evacuation began, and at 4:14 p.m. the transfer of the 96 passengers from the derailed train to the rescue train was completed.

Tests and Research

Traction Motor Mounts.--A metallurgical examination of the traction motor mounts involved in the December 15, 1981, derailment found that the lower foot mount fillet welds which attach the mount to the traction motor frame had failed. However, because the mount pounded severely against the motor frame after separation, any evidence of the failure mode in the welds was destroyed. Examination did reveal that small secondary cracks were present in the welds.

The lower foot mount bolts exhibited cracking in the thread roots, and there was evidence of fatigue. The bolts were the correct type and grade for this installation. A visual study of the threads of the bolt holes showed considerable thread wear in the first seven to eight threads, mostly fine galling and surface distortion. Examination of the fractured upper nose mount indicated a shear mode of separation.

A metallurgical examination of the traction motor mounts involved in the January 12, 1981, derailment found that the lower foot mount bolts had broken off in the holes about 1/2 inch below the surface of the mount. Both bolts had failed by reverse bending fatigue. The fatigue cracks propagated approximately halfway through the bolt before final fracture by overstress. The fracture features of the upper nose mount were typical of an overload failure. There was no evidence of fatigue or other progressive type failure in the nose mount.

A metallurgical examination of the failed traction motor mounts involved in the derailment of June 8, 1981, revealed the same fracture features as those in the derailment of January 12, 1981.

The bolts from the failed lower foot mount involved in the derailment of March 7, 1982, were missing and not recovered. Examination of the bolt holes of the lower foot mount revealed that the internal threads had stripped.

On December 28, 1977, the NYCTA issued Engineering Bulletin No. 709.1.A, requiring the installation and use of grade 5 high-strength bolts on both the upper nose mount and the lower foot mount during traction motor installation. Prior to the use of grade 5 high-strength bolts, a lower grade bolt was used. With the lower grade bolts, traction motor mount failures manifested themselves as upper nose mount bolt failures. The lower foot mount was manufactured from hot rolled, structural quality, low carbon steel plate. Calculations based on properly lubricated and torqued bolts, with a minimum of 1-inch engagement, indicate that the foot mount material is capable of supporting a grade 5 bolt when properly torqued to a range of 400 to 495 foot-pounds.

During the investigation of the December 15, 1981, derailment, when the Safety Board investigator attempted to check the torque of mounting bolts on cars in the NYCTA shop, he could not find a torque wrench in the shop and NYCTA personnel could not produce one.

5/ Wooden planks 8 feet long and 1 foot wide put together to form a 3-foot-wide bridge between the doorways of trains on adjacent tracks.

Traction Motor.--An examination of the traction motor that fell from the car involved in the derailment of December 15, 1981, revealed that 50 percent of the cooling fan located at the drive end of the armature was missing. Examination of the edge surfaces along the fracture line failed to produce any evidence of fresh clean breaks as would be expected if the missing sections of the fan had broken off during the derailment. A check of the fan mount bolt torque revealed that of the six bolts, the Nos. 1 and 5 bolts were only finger tight; the No. 4 bolt was backed out about four turns and the head was scored from rubbing contact with the motor end cover; and the No. 6 bolt was missing. The internal threads in the end of the armature for the No. 6 bolt were observed to be covered with road dirt. The lock washers from the Nos. 1 and 5 bolts could be rotated by hand and were rusty. The outer circumference of the fan exhibited sections of missing fan blade material on the tip area of all remaining blades. The failed motor was manufactured by the General Electric Company in 1949 and was last rebuilt in February 1981 by Marine Electrical Corporation, Brooklyn, New York. In June 1981, the motor was installed in the car involved in the accident.

Car Inspections.--Inspection and maintenance records indicated that the car on which the traction motor mounts failed in the derailment of December 15, 1981, had received the following inspections in 1981:

<u>Date</u>	<u>Type inspection</u>	<u>Mileage recorded</u>	<u>Miles operated between inspections</u>
6/2	A	942,463	(No entry)
8/27	(No entry)	950,197	7,834
9/23	A	953,977	3,780
11/6	B	959,625	5,648
12/2	A	962,944	3,319

In addition to the scheduled A and B inspections, there was reported a total of 36 preservice inspections performed during the 220-day search period, or an average of 1 inspection every 6.1 calendar days. The last reported preservice inspection was accomplished on December 10, 1981, 5 days and 1,330 miles prior to the derailment.

The car with the failed traction motor mounts in the derailment of January 12, 1981, had received the following inspections in 1980:

<u>Date</u>	<u>Type inspection</u>	<u>Mileage recorded</u>	<u>Miles operated between inspections</u>
2/28	A	293,145	(No entry)
2/29	C	293,295	150
7/8	A	304,038	10,743
7/19	B	304,358	320
9/19	A	316,107	11,749
9/22	C	316,301	194

In addition to the scheduled A, B, and C inspections, two preservice inspections had been performed. The last preservice inspection was on December 15, 1980, 28 days and 3,734 miles prior to the derailment.

The car with the failed traction motor mounts in the derailment of June 8, 1981, received the following inspections in 1981:

<u>Date</u>	<u>Type inspection</u>	<u>Mileage recorded</u>	<u>Miles operated between inspections</u>
1/7	C	874,151	(No entry)
4/13	B	887,475	13,324
5/22	A	893,975	6,500

In addition to the scheduled A, B, and C inspections, there were 22 preservice inspections performed. The last inspection of the car was the A inspection performed on May 22, 1981, 18 days and 1,927 miles prior to the accident.

On February 3, 1981, planned programmed maintenance work was performed on the car with the failed traction motor mounts in the derailment of March 7, 1982. The maintenance involved extensive truck work which would include inspection of the traction motor mounts. The car also received additional inspections in 1981 and 1982 as follows:

<u>Date</u>	<u>Type inspection</u>	<u>Mileage recorded</u>	<u>Miles operated between inspections</u>
4/8/81	C	326,634	(Unable to calculate
12/21/81	B	(No entry)	because mileage figure
2/23/82	C	365,512	lacking for the B inspection)

No preservice inspections were recorded. The last inspection of the car was the C inspection performed on February 23, 1982, 13 days and 1,387 miles prior to the accident. This car also had been inspected during the one-time inspection conducted in January and February 1982 to determine if motors were down on axles.

Other Information

In its report of the investigation of a derailment on December 12, 1978, involving a broken wheel on an NYCTA car, the Safety Board found that a contributing cause in the derailment and similar derailments was the lack of adequate inspection procedures. 6/ In its report of the investigation of eight subway train fires on the NYCTA, the Safety Board recommended that the NYCTA reduce the 10,000-mile interval between major subway car inspections and enhance the quality assurance of subway car inspections. In a letter of April 12, 1982, to the Safety Board, the NYCTA advised that an A inspection had been instituted in December 1980 to provide for inspection and maintenance every 5,000 miles. Systemwide implementation of the A inspection was completed in November 1981. In the area of quality assurance, the NYCTA advised that on October 17, 1981, the quality assurance department was reorganized and its responsibility divided between the northern and southern chiefs of operations. The objective of this reorganization was to provide each superintendent with direct control of quality assurance personnel operating in a division, enabling the superintendent to "closely monitor the quality of work and take quick action should a potential maintenance or inspection problem arise."

During this investigation, the Safety Board recommended on March 18, 1982, that the NYCTA:

6/ Railroad Accident Report--"Derailment of New York City Transit Authority Subway Train, New York, New York," December 12, 1978 (NTSB-RAR-79-8).

7/ Railroad Accident Report--"Eight Subway Train Fires on New York City Transit Authority with Evacuation of Passengers" (NTSB-SIR-81-5).

Immediately perform a one-time, fully supervised undercar inspection of all R10 through R44 subway cars to determine if traction motor mount failure has occurred. Cars with evidence of traction motor mount failure or displaced traction motors should be removed from service until the defect has been corrected. (Class I, Urgent Action) (R-82-6)

Review existing traction motor periodic inspection procedures, including inspection intervals, immediately, and implement necessary changes to correct any deficiencies in the procedures for detection and repair of failed traction motor mounts. (Class I, Urgent Action) (R-82-7)

An NYCTA corrective action plan, outlined in its March 18, 1982, report of the March 7, 1982, derailment, states that a visual inspection procedure was instituted immediately after the derailment to assure that there were no other traction motors on axles. This was another one-time inspection similar to the one which found the basis for the NYCTA report to the Safety Board in February 1982. The plan also established procedures to correct the failures of the traction motor mounts.

Also, following the March 7, 1982, derailment, the NYCTA issued an internal report, dated March 19, 1982, of its findings and of what action is to be taken. The report stated, in part:

CONCLUSION:

Based on the foregoing information, the Final Review Committee has determined that the derailment of the 2:54 PM #2 from Utica Avenue resulted from the #2 traction motor of Car #7959 becoming dislodged from the truck and falling to the roadbed.

RECOMMENDATION

Car Maintenance Department should conduct an in-depth investigation to determine the cause for the dropped motor and submit recommendations for corrective action to prevent a recurrence of this accident.

ACTION TAKEN:

The following four-part Corrective Action Plan was placed into effect immediately following the derailment of car #7959:

1. A visual inspection procedure was instituted immediately after the derailment to assure that there are no other traction motors on axles.
2. All traction motor anchor bolts will be checked to assure that the fleet is completely equipped with Grade 5 bolts and that all Grade 5 bolts are torqued to 400/480 foot pounds. The Jerome fleet will be processed first. Resources will then be moved to Pelham for program continuation while additional torque wrenches are purchased for program expansion.

When additional torque wrenches become available, the total program will then be transferred to the A-B-C inspection cycle with a maximum conclusion date of 120 days.

3. Beginning Tuesday, March 9, 1982, a program was initiated to check all motors at outside vendors, all motors designated to be sent to outside vendors, all motors transferred from truck to truck within our own facilities with dye penetrant to assure the absence of anomalies in the motor shell frame mounting sections. This program will continue until three portable magnaflux machines are purchased and delivered.
4. A requisition was signed on January 14, 1982, and rerequisitioned on March 8, 1982, to expedite the purchase of three portable magnaflux machines. Expected delivery date is two weeks. On delivery of the magnaflux machines, the dye penetrant program will be suspended and magnaflux will be instituted and maintained as a standard preventive maintenance procedure.

The NYCTA report further stated that as of March 11, 1982, the firm of Louis T. Klauder and Associates, Consulting Engineers has been retained to investigate installation procedures and practices for various classes of subway cars used by the NYCTA and to recommend engineering and/or procedural changes to improve the reliability of traction motor mountings.

The NYCTA also stated:

The car Maintenance Engineering Department is presently engaged in a comprehensive testing and evaluation program with emphasis placed on:

1. Comparative breaking strengths of bolts presently in use.
2. Condition of bolts presently in storeroom stock.
3. The wear rate of motor safety hangers of a motor riding dropped on a rotating axle.
4. The condition of the mounting brackets of motors presently held as stock by use of nondestructive testing techniques.
5. Any correlation that may exist between motor age and mounting failure.
6. Laboratory testing of mounting brackets and motor shells.

ANALYSIS

The Accidents

The accident of December 15, 1981, occurred when the safety lugs were worn off the traction motor that was lying on the rotating lead axle of the trailing truck of the third car. When sufficient material had been worn off the safety lugs and motor housing, the traction motor was then loose enough to drop to the track. When the traction motor dropped to the track and reduced the under-car clearance, it was struck by other components of the truck, and the truck was then knocked out of the center casting, which is designed to keep the truck under the car and in its correct position. When the truck was no longer in the center casting, it came out from under the car; the car body, no longer being carried by the truck, then dropped to the track level. The loose truck was derailed after it struck and bounced over the loose traction motor. The derailed truck was then struck by the lead truck of the fourth car, which derailed when it was dislodged.

from its proper position. A similar derailment sequence also occurred in each of the other three derailments.

Inspection and Maintenance

The car which initiated the accident that occurred on June 8, 1981, should not have been in operation. The car had been identified as being defective the previous day and sent by the command center to a yard for repairs. The smoke and noise associated with the car was probably caused by the traction motor lying against the axle of the car. The noise heard was most likely from the metal-on-metal contact with the rotating axle, and the smoke was most likely from the burning grease since the coupling, shaft, and gear box were damaged. Allowing a defective car to be returned to service without any repairs being performed indicates that the NYCTA's current control procedures to insure that repairs are made to defective cars are inadequate.

The NYCTA does not require that a defect tag be attached to a defective car or that a notice be placed in the motorman's cab of the train to indicate that the train has a defective car. The prescribed preservice inspection of a train probably would not detect a traction motor lying on the axle of a standing train because the traction motor area of the car is hidden by the truck frame and wheel from the view of a person walking beside the car. If there had been some obvious indication, such as a tag, that the car was defective, the crew would have been aware of the defect and probably would not have put the car into service.

When the assistant supervisor telephoned the yardmaster regarding the numbers of the cars to be held for repairs, the yardmaster apparently failed to record the information and failed to remember it when he sent the train out for service. Later, neither the train trouble team, the assistant supervisor at the inspection barn, nor the yardmaster made an attempt to locate the car and have it returned to the yard for repairs. The irresponsible handling of this car after it was found to be defective resulted in a derailment that could have been prevented.

In the March 7, 1982, derailment, the car involved had received a B inspection on December 21, 1981; it had been subject to the one-time inspection for traction motors riding on axles conducted and reported by the NYCTA in February 1982; and it had received a C inspection, the most comprehensive inspection conducted by the NYCTA, on February 23, 1982, just 13 days before the traction motor dropped to the tracks and derailed the car. For this traction motor to fall to the tracks, it was necessary for the safety lugs to be worn off and the motor housing be worn 1 inch into the motor; this would indicate that the motor was probably down on the axle when the car received the C inspection and mount bolt problems existed when it received the two previous inspections.

The one-time inspection program by the NYCTA which led to its report to the Safety Board that two traction motors were found on the axle did not prevent the derailment of March 7, 1982. If the inspection successfully detected all the traction motors that were down, it was not thorough enough to identify distressed bolts and welds leading to at least one other motor being down within a short time span. The finding of two traction motors down on axles when considered in conjunction with the four derailments that occurred in a short time span is significant since one traction motor falling from a car can cause a major derailment and disable an entire subway train consisting of 10 cars.

A search of the inspection and maintenance record spanning 10 months preceding the derailment on March 7, 1982, did not reveal any preservice inspections having been performed on the car in the 7 months since the inception of the preservice inspection requirement. The NYCTA's stated purpose for this inspection was to detect and repair a potential problem. It would appear from this record that the compliance with the preservice inspection requirement has not been implemented effectively by the NYCTA or that its recordkeeping is faulty.

The detection of a traction motor in contact with and riding on a rotating axle should have been possible during any one of the many yard moves to which the car was subjected. The method of detection could have been as simple as having someone along a track to listen for any metal-to-metal scraping noises in passing cars and then locating the source. If an individual assigned to preservice inspections were to be on hand as trains entered the yard, this monitoring could be accomplished.

The existing NYCTA inspection and maintenance procedures are not accomplishing the intended purpose of detecting and correcting defective car components. This is evident in the failure of NYCTA inspection and maintenance crews to detect the dropped traction motors that resulted from motor mount failures. Thus, the cars remained in service with the axles wearing away the safety nose lugs and the motor housings sufficiently to allow the motors to drop to the tracks, derailing the four trains.

The A inspection procedures instituted in December 1980 and fully implemented in November 1981 did not detect the failed motor mounts, nor did the B and C inspections which are intended to be the most comprehensive of all the inspection procedures. The preservice inspections, which had begun in July 1981, utilizing additional personnel, also did not accomplish the NYCTA's stated intent of "permitting detection and repair of a potential problem." The Safety Board concludes that the inspections are not sufficient in detail to detect incipient traction motor mount failures because the criteria are vague as to the scope and procedures for the inspection of specific components.

Two of the accidents occurred after the reorganization of the quality assurance personnel on October 17, 1981. Apparently, NYCTA superintendents still are not able to "closely monitor the quality of work done and take quick action should a potential maintenance or inspection problem arise." The NYCTA management must reexamine its methods of achieving the goal of detecting defects before they result in problems and accidents. One step could be revising the C inspection requirements to include a closer examination of all traction motor mount welds and the removal, examination, and retorquing of the motor mount bolts.

The condition of the traction motor cooling fan on the car involved in the December 15, 1981, accident, although not a contributing factor in the motor failure, further demonstrated the poor quality of maintenance and inspection on the NYCTA. Sections of the fan had broken off before the accident, and some of the mounting bolts were loose. The lock washers found on the loose bolts were loose and rusted from long-time exposure. One bolt had been missing since the motor was installed on the car. These conditions all existed during the last B inspection on November 6, 1981, but were not detected. It is also apparent that when the traction motor was rebuilt, the vendor failed to properly torque the fan mounting bolts. The arrangement of the motor housing and cooling fan will not permit a mounting bolt to back out a sufficient distance to fall completely out. Therefore, the motor with the missing bolt must have been returned by the vendor in that condition after it was rebuilt.

Traction Motor Mount Bolts

The 1977 engineering bulletin requiring the use and installation of the stronger grade 5 bolts was directed to preventing the upper nose mount bolt failures being experienced at that time. In each of the four derailments discussed here, the traction motor mount failures initiated at the lower foot mount. In the December 15, 1981, accident, the lower mount attachment welds failed, followed by failure of the upper mount. However, examination of the lower mount bolts did reveal fatigue cracks in the thread root area. In the January 15, 1981, and the June 8, 1981, derailments, the failures of the lower foot mounts resulted from the bolts failing in fatigue. This placed an overload on the upper nose mounts, which subsequently failed and allowed the traction motors to drop onto the axles. In the March 7, 1982, failure, although the lower mount bolts were missing and were not recovered, examination of the lower mount boltholes revealed that the internal threads were stripped.

It appears that the decision to replace the original mount bolts with the higher strength bolts was made without a system analysis of the mounts, bolts, or alignment being made. This decision may have only transferred the failure point to the lower mount bolts. Moreover, it is probable that in all of the derailments, both the upper and lower mount bolts were improperly torqued. Since no torque wrench could be found in the shop during the investigation of the December 15, 1981, derailment and it is necessary for the NYCTA to obtain torque wrenches to carry out its recently announced action plan, it is likely that when applying the bolts the maintenance personnel have been using standard wrenches which would lead to improper torquing of the bolts and resulting failure. The condition of the mount bolting surface, with respect to inadequate perpendicularity and parallelism, was also a contributing factor. Any irregularities in the motor mount bolting surfaces could have resulted in low or false torque reading and/or bending of the bolts during the tightening sequence. Both of these conditions increased the probability of failure; however, with the proper analysis these problems might have been identified and corrected before these accidents occurred.

NYCTA Action Plan

The NYCTA's report regarding the March 7, 1982, derailment establishes procedures that could, if properly implemented, correct many of the problems with the traction motor mounts. However, the Safety Board believes that some preventive measures should have been taken immediately following the first derailment caused by motor mount failure. Moreover, the first two derailments indicated a continuing problem with the traction motor mounts and should have caused the NYCTA management to conduct more frequent inspections of, and establish corrective measures for, the traction motor mounts. Even the third and most serious of the derailments, in which 12 passengers were injured, 5 of whom required hospitalization, did not result in an action plan to eliminate the problem. The NYCTA delayed taking any positive corrective action until after four derailments occurred.

Even though the plan demonstrates a commitment to eliminating the motor mount failure problem, the plan may not be as effective as possible. The plan should require not only a check for proper torquing of the grade 5 bolts, but also removal and examination of the bolts for evidence of fatigue at each C inspection. In addition to the external inspection of motor mounts, an internal inspection of the traction motors should be made to insure that maintenance work has been done properly. The use of magnaflux machines when used on a preventive maintenance program will identify defects in the motor mounts.

Survival Aspects

When the derailments occurred while cars were still in a station alongside a platform, the motormen and conductors responded quickly in discharging the passengers through those cars onto the platform. However, in those cases where the train was not at a station or a part of the train was separated and passengers could not pass through the cars to a station platform, delays were encountered in notifying the fire department for assistance. In the derailment of December 15, 1981, 6 minutes elapsed between the time the command center notified the city's Emergency Medical Service and the time it notified the fire department -- a total of 12 minutes after the accident occurred. The command center apparently had become involved in notifying NYCTA personnel and departments when it should have immediately notified the fire department, which is the only organization that has the equipment and manpower needed to evacuate passengers.

In the derailment of March 7, 1982, the use of a rescue train was successful. However, the decision to use a rescue train was not made until 22 minutes after the accident. It then took another 6 minutes to locate a train and to discharge passengers so that it could be used as a rescue train. Then, 16 minutes more were used to prepare the train and to travel to a position adjacent to the derailed train. The NYCTA should review its procedures for using rescue trains and make necessary changes to reduce the elapsed time from accident to evacuation.

CONCLUSIONS

Findings

1. In each of the four accidents, the traction motor mounts failed, the motors came in contact with a rotating axle, the safety lugs were worn off, and the traction motors fell to the tracks and caused the trucks to derail.
2. In each of the four accidents, the traction motors that fell from the cars resulting in the derailments had been riding on the rotating axle for several hundred miles following failure of the upper nose mount and the lower foot mount which secured the traction motors to the truck transom.
3. The condition of the traction motors could have been detected during any one of the car inspections or during one of the many yard moves to which the cars would have been subjected if someone had been on the right-of-way to observe and listen as the train passed.
4. At the time of these derailments, the NYCTA maintenance forces were not consistently adhering to good bolt torquing practices when installing or checking traction motors.
5. Because of inadequate safeguards to prevent a defective car from being placed in service, the car involved in the June 8, 1981, derailment was permitted to be returned to service despite the fact that it was known to be defective.
6. At the time of these derailments, the NYCTA was not checking the quality of work on traction motor overhauls to insure that the motors were in proper operating condition.

7. To reduce the probability of future traction motor mount failures, the C inspection should be revised to include a closer examination of all traction motor mount welds and the removal, examination, and retorquing of the motor mount bolts.
8. The NYCTA should review its procedures for using rescue trains and make necessary changes to reduce the elapsed time from accident to evacuation.

Probable Cause

The National Transportation Safety Board determines that the probable cause of each of the four derailments was the failure of the inspection procedures of the New York City Transit Authority to detect that the traction motor mounts had failed and that the motors were riding on axles before they dropped to the tracks. Contributing to the accidents was the failure of the New York City Transit Authority to take prompt action to detect, analyze, and correct the cause of the motor mount failures.

RECOMMENDATIONS

As a result of its investigation of these four derailments, the National Transportation Safety Board recommends that the New York City Transit Authority:

Following its planned wear tests of the safety lugs, review the maintenance requirements of the "B" and "C" inspections to determine if the interval between inspections will permit a motor to drop onto the axle and wear sufficient material from the motor safety lugs and motor frame to allow the traction motor to fall to the tracks. Change the inspection interval to prevent this occurring if required. (Class II, Priority Action) (R-82-49)

Modify the maintenance and inspection practices in all New York City Transit Authority shops to provide improved quality control of work accomplished during car maintenance. (Class II, Priority Action) (R-82-50)

Establish positive safeguards to prevent the return to service of cars with known defects until they are repaired. (Class II, Priority Action) (R-82-51)

At each "C" inspection require the removal and examination of the traction motor mount bolts for cracks, bending, thread distress or other discrepancies; discard and replace all defective parts. (Class II, Priority Action) (R-82-52)

Institute a running noise test on all subway cars when entering a yard for layover to determine if metal-on-metal rubbing or scraping is evident, and correct all discrepancies. (Class II, Priority Action) (R-82-53)

Review the current procedures for using rescue trains, and make necessary changes to reduce the elapsed time from accident to evacuation. (Class II, Priority Action) (R-82-54)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G.H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

PATRICIA A. GOLDMAN, Vice Chairman, did not participate.

July 15, 1982

APPENDIXES

APPENDIX A

INVESTIGATION

When notified of the derailments on January 12, 1981, June 8, 1981, and March 7, 1982, an investigator from the Safety Board's New York Field Office was dispatched to the scene on each occasion to conduct an investigation. When notified about the December 15, 1981, derailment, the Safety Board dispatched an investigator from the New York Field Office and an investigative team from Washington, D. C., to the scene. Investigative groups were established for operations, equipment, and human factors.

APPENDIX B

**NEW YORK CITY TRANSIT AUTHORITY
"A" INSPECTION REQUIREMENTS**

November 21, 1980

"A" INSPECTIONS

NECESSARY INSPECTION FUNCTIONS:

- 1. BATTERIES**
- 2. COMPRESSORS**
- 3. MOTOR GENERATORS**
- 4. AIR CONDITIONING, FANS AND HEAT**
- 5. WHEELS**

"A" INSPECTION

NECESSARY INSPECTION FUNCTIONS:

- 1. BATTERIES -**
 - A) WATER WHEN NECESSARY**
 - B) CHECK BATTERY OUTPUT (CELLS)**
 - C) REPORT DEFECTIVE CELLS TO FOREMAN**

NOTE: NO REPAIRS OR REPLACEMENT

November 21, 1980

"A" INSPECTION

NECESSARY INSPECTION FUNCTIONS:

2. COMPRESSORS -

- A) REPLACE BRUSHES WHEN NECESSARY
- B) LUBE
- C) CHECK GOVERNOR - REPLACE TIPS AND SHUNT,
IF NECESSARY
- D) REPORT DEFECTIVE UNITS TO FOREMAN

NOTE: NO OTHER REPLACEMENT OR REPAIR

"A" INSPECTION

NECESSARY INSPECTION FUNCTIONS:

3. MOTOR GENERATORS -

- A) REPLACE BRUSHES WHEN NECESSARY
- B) CHECK VOLTAGE OUTPUT - ADJUST AS REQUIRED
- C) REPORT DEFECTS TO FOREMAN

**NOTE: B) ADJUST POTS OR VARIABLE RESISTORS,
NO REPLACEMENT OR REPAIR.**

November 21, 1980

"A" INSPECTION

NECESSARY INSPECTION FUNCTIONS:

4. AIR CONDITIONING, FANS AND HEAT

- A) CHECK OPERATION BY FLASHING/ON & OFF
- B) REPLACE ALL FILTERS
- C) REPLACE FAN BRUSHES AS REQUIRED IN FANS NOT RUNNING
- D) REPORT DEFECTIVE UNITS TO FOREMAN
- E) REPLACE FLUORESCENT TUBES (MAX. 2 PER CAR)

NOTE: C) FAN BRUSHES ALSO IN A.C. UNITS THAT'S NOT RUNNING

"A" INSPECTION

NECESSARY INSPECTION FUNCTIONS

5. WHEELS -

- A) EXAMINE ALL WHEELS FOR CRACKS, THERMAL CHECKS, SIGNS OF OVERHEATING, CHECK FOR DEFECTS.
- B) GAUGE ALL WHEELS
- C) REPORT DEFECTS TO FOREMAN
- D) SHOP WHEN NECESSARY

APPENDIX C

NEW YORK CITY TRANSIT AUTHORITY "B" AND "C" INSPECTION REQUIREMENTS

NEW YORK CITY TRANSIT AUTHORITY CARS & SHOPS INSPECTION PROCEDURES FOR R-10 TO R-44 CONTRACT CARS

OPER NO.	DESCRIPTION	Job No. IP 10.6.0
	<u>TRACTION MOTORS</u>	Sheet 1 of 2
	"B" INSPECTION	
	TRACTION MOTORS Use Truck Work Manual, Section 7.2.0 See figures 1 and 2	
7.2.1	Wipe commutator cover and remove	
7.2.2	Inspect internal condition of traction motor	
7.2.3	Inspect motor brushes	
7.2.4	Check brush holders	
7.2.5	Inspect for commutation	
7.2.6	Inspect string bands	
7.2.7	Replace commutator cover	
7.2.8	Inspect fan blade	
7.2.9	Inspect external condition of traction motor	
	TRUCK ELECTRICAL Use Truck Work Manual, Section 7.13.0 See figures 1, 2, & 3	
7.13.1	Inspect all electrical cables. (Ground, Trolley and Motor cables)	
7.13.2	Inspect all cable cleats, sleeves and brackets.	
7.13.3	Inspect all cable terminals	
	"C" INSPECTION Same as "B", above, plus: Change all brushes	
7.2.3(E)		
	AXLE GROUND BRUSH ASSEMBLY Use Truck Work Manual, Section 7.14.0 See figure 1	
7.14.1	Inspect axle ground brush assembly	

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NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS INSPECTION PROCEDURES
FOR R-10 TO R-44, CONTRACT CARS

OPER. NO.	DESCRIPTION	Job No. IP 10.6.0
	TRACTION MOTORS CONTINUED: "C" INSPECTION	Sheet 2 of 2
	MAIN MOTOR DISCONNECT BOX Use Propulsion Control Work Manual, Section 6.11.0 See figure 1	
.1	Inspect disconnect box external condition	
.2	Inspect disconnect box internal condition	
.3	Test for grounded traction motors	
.4	Test for open traction motors	
.5	Replace covers.	
	MAKE ADJUSTMENTS AND/OR REPAIRS AS REQUIRED IN ALL OPERATIONS	

00160

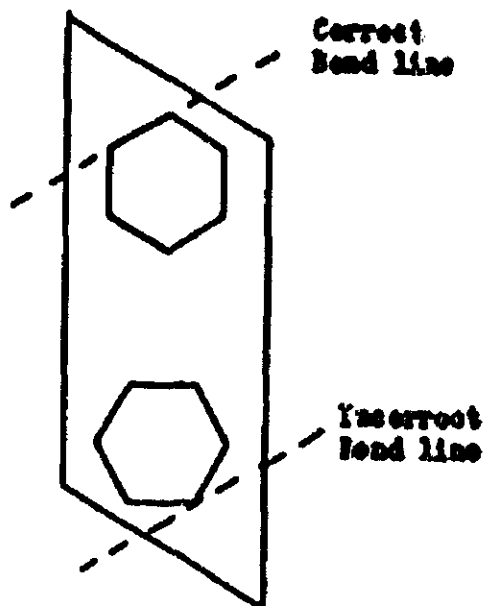
NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
FOR R-10 TO R-42 CONTRACT CARS

OPER. NO.	DESCRIPTION	WM 7.2.0
7.2.0	<p><u>TRACTION MOTORS</u> Westinghouse Electric Type - 1447 & 1447F General Electric Type - 1240</p> <p>See figures 1 & 2</p>	
7.2.1	Wipe dirt away from commutator cover before removing. Remove cover. If cover is missing - report to foreman.	
7.2.2	<p>Inspect internal condition of motor for:-</p> <p>(a) Chafed, frayed or broken insulation wiring at brush holders, field and main wiring. If bare wire is exposed replace wiring in that section. If wire is not exposed, tape chafed area with at least two layers of friction tape and tie wires to prevent chaffing.</p> <p>(b) Thrown solder from commutator bar.....Report to foreman</p> <p>(c) Damaged bands or coils on armature.....Report to foreman</p> <p>(d) Dropped armature - if fan shows signs of rubbing on inside of motor shell....report to foreman.</p>	
7.2.3	<p>Check brushes for:-</p> <p>(a) Wear - Replace if worn shorter than 1 3/8" W.E. 1477 12-38-2055 G.E. 1240 12-38-0071</p> <p>(b) Check brush for being "BOX BOUND". Lift up brush spring and pull pigtail slightly to see if brush is free in holder. Clean holder if necessary by wiping with clean rag or by brushing. The slight pull on pigtail will check the bond between brush and pigtail.</p> <p>(c) Check shunt/pigtail for frayed, broken and burnt. -- Replace When replacing brushes, do not twist shunt/pigtail.</p> <p>(d) If one or more brushes requires replacement, all brushes on that commutator must be replaced.</p> <p>(e) All brushes are to be changed on "C" inspection.</p>	

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**NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS PROPULSION CONTROLS WORK MANUAL
FOR R-10 TO R-44 CONTRACT CARS**

OPER. NO.	DESCRIPTION	W 7.2.0
7.2.8	<p>Inspect fan blade for:-</p> <ul style="list-style-type: none"> (a) Tightness (b) Damaged (c) If rubbing housing/shell <p>If defective, report to foreman.</p>	
7.2.9	<p>Inspect external condition of motor for:-</p> <ul style="list-style-type: none"> (a) Loose pole piece mounting bolts (b) Loose motor nose mounting bolts (c) Loose motor feet mounting bolts <p>If any loose bolts found - report to foreman</p> <p>(d) Signs of overheating (burnt paint) - check for 'dropped' armature (see Oper. No. 7.2.2 (d)).</p>	



When using locking tabs to secure motor foot mounting bolts, bend tab firmly against the flat surface of the bolt head. Bending against the corner of the head will NOT lock bolt. If locking tabs are not used, lockwashers must be used.

FIGURE 2

Locking Tab Application

00166

NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
(FOR R-10 TO R-42) CONTRACT CARS

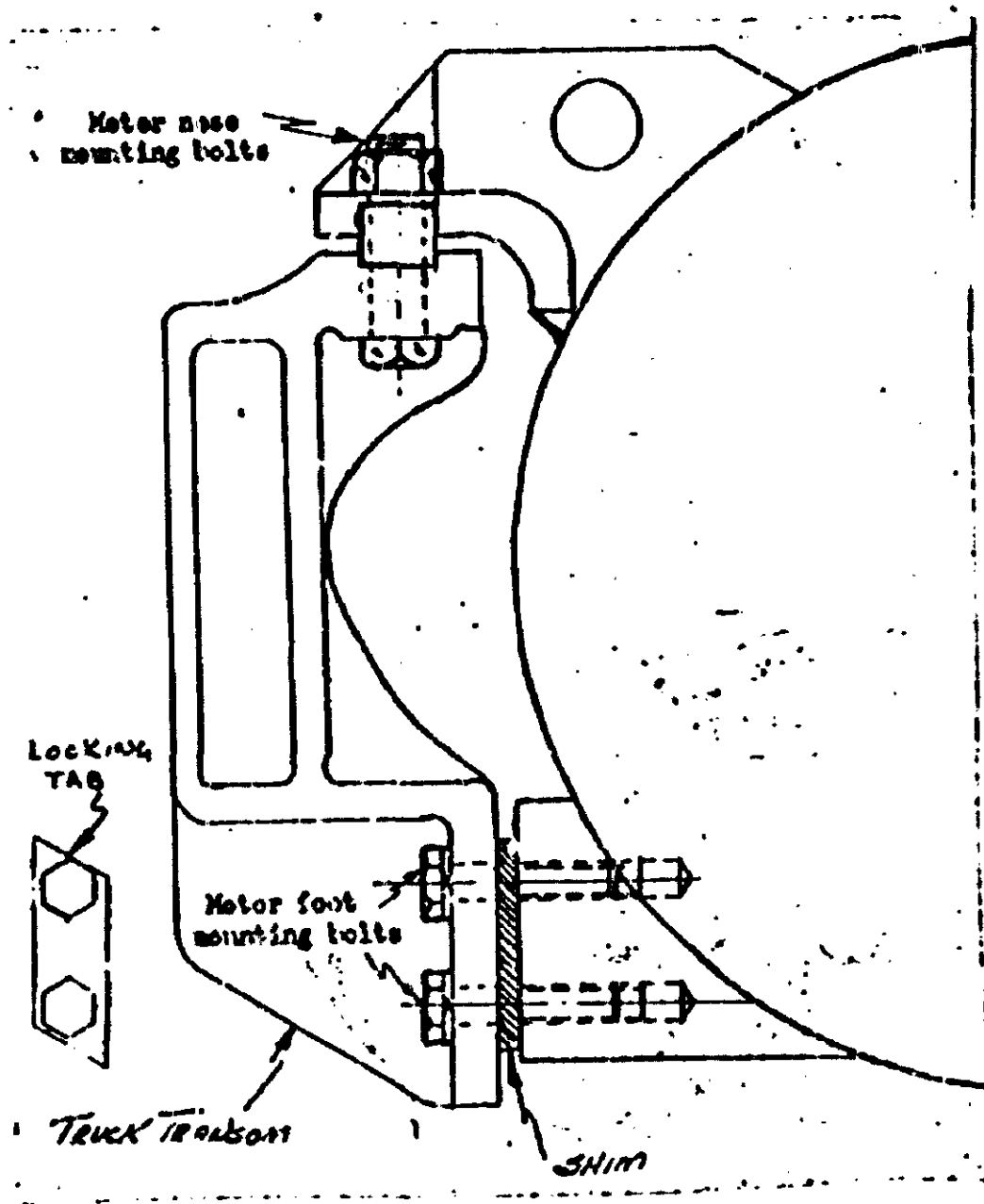
OPER. NO.	DESCRIPTION	WM 7.2.0
7.2.9	 <p>The diagram illustrates the assembly of traction motor bolts. It shows a side view of a motor assembly with labels for 'Motor nose mounting bolts' at the top, 'Motor foot mounting bolts' at the bottom, 'Truck Trunion' on the left, and a 'SHIM' on the right. A detail view on the left shows a 'LOCKING TAB' with two hexagonal holes. A note at the bottom states: 'Lockwashers must be used on motor foot mounting bolts if locking tabs are not used.'</p>	

FIGURE 2A

TRACTION MOTOR BOLTS

Lockwashers must be used on motor foot mounting bolts if locking tabs are not used.

00167

NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS INSPECTION PROCEDURES
FOR R-10 to R-44 CONTRACT CARS

OPER NO	DESCRIPTION	Job No. 10.25.0
	<u>TRUCKS</u>	
	<u>"B" INSPECTION</u>	
	<u>TRUCK STRUCTURES</u>	
	Use Work Manual No. 7.1.0	
.1	Inspect truck frame	
.2	" hangers	
.3	" bolsters	
.4	" center castings	
.5	" spring plank	
.6	" pedestal tie straps	
.7	" springs	
.8	" woodruff height adjuster	
.9	" pins, bolts, nuts	
.10	" shock absorbers	
.11	" wear plates and bumpers	
.13	" ground straps and plates	
.14	Gauge carbody height	
	<u>FLEXIBLE COUPLING/MOTOR COUPLING</u>	
	Use Work Manual No. 7.3.0	
.2,4,5	Inspect coupler	
.1,3	Inspect coupler flange bolts, plugs, seals	
	<u>GEAR CASE</u>	
	Use Work Manual No. 7.5.0	
.1,2	Inspect gear case	
.3	" plugs	
.4	" oil	
	<u>JOURNAL BOXES</u>	
	Use Work Manual No. 7.4.0	
.1	Inspect journal box	
.2	" end cap, bolts, safety wire	
.3	" wheel truing plug	
.4	" wear plates	
	<u>WHEELS AND AXLES</u>	
	Use Work Manual No. 7.6.0	
.1	Inspect wheels	
.2	Gauge wheels	
.3	Inspect axles (Loose wheels)	
	MAKE ADJUSTMENTS AND/OR REPAIRS AS REQUIRED IN ALL OPERATIONS	

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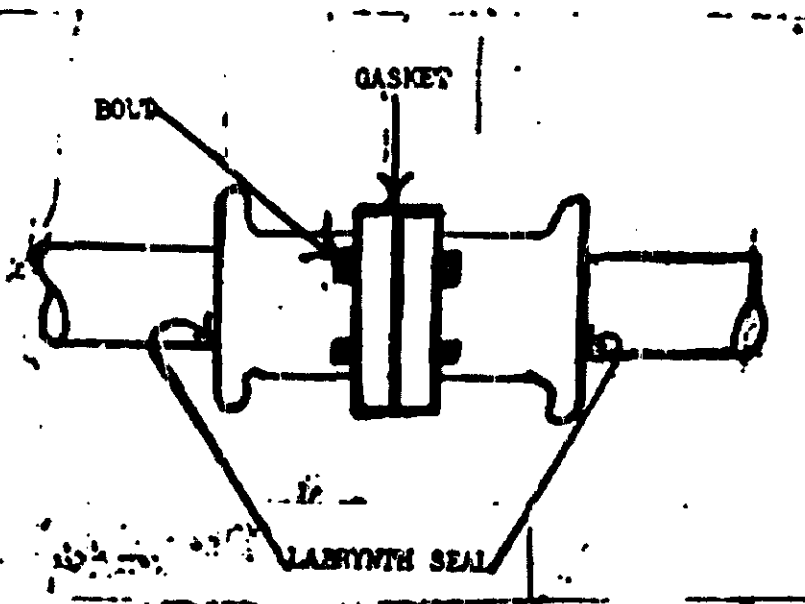
NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS INSPECTION PROCEDURES
FOR R-10 to R-44 CONTRACT CARS

OPER NO	DESCRIPTION	Job No. 10.25.0
	TRUCK "B" INSPECTION (CONT.)	
	<u>SIDE BEARING</u>	
	Use Work Manual No. 7.1.0	
.12	Inspect housing	
	" rollers	
	" friction plate	
	" shims, clearance	
	<u>SENSING EQUIPMENT, TACHOMETER GENERATOR</u>	
	(Use Work Manual No. 7.7.0)	
.1	Inspect wayside sensor coil, IDENTRAL coil	
.2	Inspect speed sensor	
.3	Inspect tachometer generator -	
	A. General condition	
	<u>"C" INSPECTION</u>	
	ALL OF "B" INSPECTION PLUS:	
	<u>FLEXIBLE COUPLING/MOTOR COUPLING</u>	
	(Use Work Manual No. 7.3.0)	
.6	Lubricate	
	<u>JOURNAL BOXES</u>	
	(Use Work Manual No. 7.4.0)	
.5	Inspect and Lubricate Journal Bearings	
	<u>SENSING EQUIPMENT, TACHOMETER GENERATOR</u>	
	(Use Work Manual No. 7.7.0)	
.3	Inspect tachometer generator -	
MAKE ADJUSTMENTS AND/OR REPAIRS AS REQUIRED IN ALL OPERATIONS		

00179

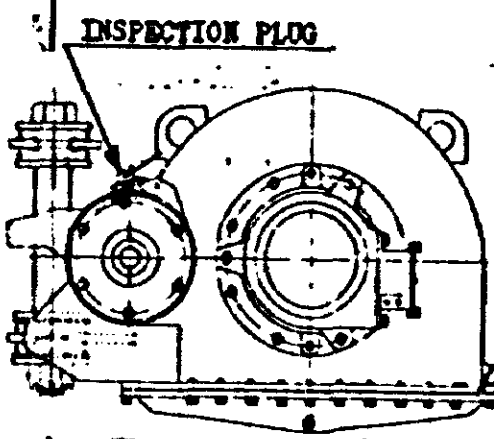
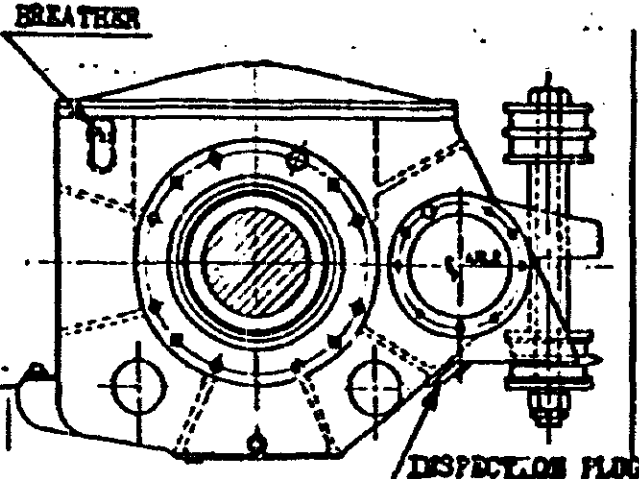
NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
FOR R-10 TO R-44 CONTRACT CARS

OPER. NO.	DESCRIPTION	Y.M.T. 3.0.
	MOTOR AND PINION COUPLINGS.	
7.3.1.	INSPECT BOLTS. A. IF LOOSE REMOVE BOLTS, APPLY # 267 GAUGE INTO BOLT HOLE. IF BOLT HOLE ACCEPTS GAUGE INDICATING THAT THE BOLT HOLE IS WORN OR ELONGATED, REPORT IT TO YOUR FOREMAN. B. REPLACE ALL LOOSE COUPLING BOLTS WITH NEW ONES.	
7.3.2.	INSPECT COUPLER GASKET. IF COUPLING GASKET IS BROKEN (STICKING OUT OF COUPLER) REMOVE ALL BOLTS AND REPLACE A NEW GASKET.	
7.3.3.	INSPECT SEALS. GREASE SEALS BOTH ON THE ARMATURE AND PINION SIDES OF THE COUPLING (LABYRINTH SEALS). IF SEALS ARE LEAKING, REPORT IT TO YOUR FOREMAN.	
7.3.4.	INSPECT FOR WEAR. A. FIRMLY HOLD COUPLER AND TRY TO ROTATE IN EACH DIRECTION. IF PLAY IS FELT REPORT IT TO YOUR FOREMAN. B. TRY TO MOVE COUPLER Laterally IN EACH DIRECTION IF PLAY IS FELT - REPORT IT TO YOUR FOREMAN. C. TRY TO MOVE COUPLING UP AND DOWN IF PLAY IS FOUND REPORT IT TO YOUR FOREMAN.	
7.3.5.	INSPECT FOR OVERHEATING. IF ANY INDICATION OF HEAT IS VISIBLE (BLUE COLOR). REPORT IT TO YOUR FOREMAN.	
7.3.6.	LUBRICATION A. REMOVE BOTH PLUGS FROM COUPLING HALVES. B. PUMP GREASE INTO ONE SIDE OF PLUG HOLE, UNTIL GREASE IS OBSERVED COMING OUT OF OPPOSITE PLUG HOLE, STOP PUMPING. C. REPLACE PLUGS. D. CHECK FOR LEAKS AT GASKETS AND SEALS AFTER LUBRICATION IS DONE. IF LEAKING REPORT TO FOREMAN.	



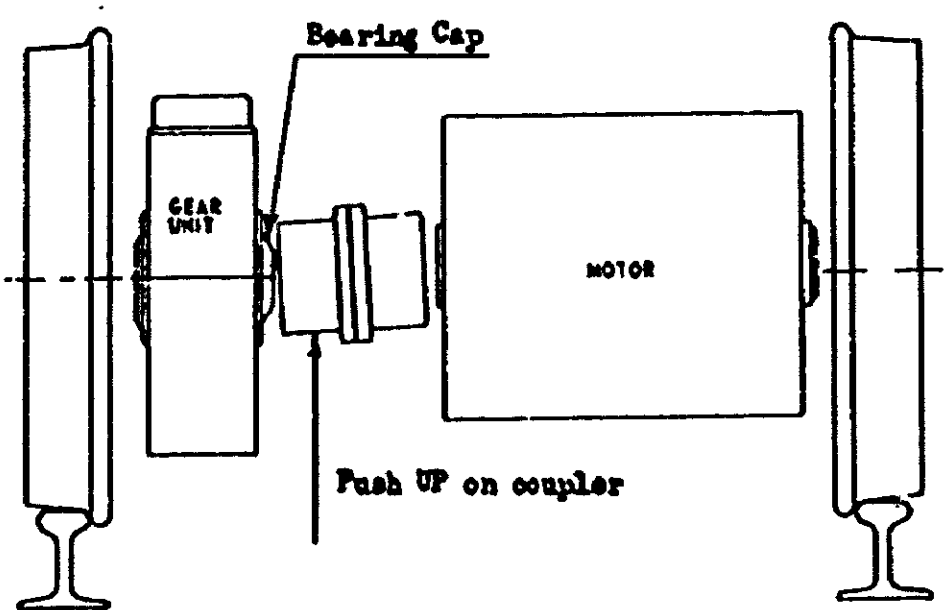
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NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
FOR R-10 TO R-44 CONTRACT CARS

OPER. NO.	DESCRIPTION	WM 7.5.0
7.5.0	Gear Units	
7.5.1	<p>Examine gear case for signs of oil leakage and damage at:-</p> <p>A. Labrynth seal. Some oil will seep past labrynth seals on the axle and pinion ONLY when gearcase is new or has recently been overhauled. Dust and dirt will adhere to gearcase and appear dry. THIS IS NORMAL. If gearcase leaks, dust and dirt on gearcase will be wet with oil. Car should then be sent to shop for repairs.</p> <p>B. High and low bearing caps Usually loose bolts will permit oil to leak out. Tighten loose bolts. If bolts are not loose, car should be sent to shop for repairs.</p> <p>C. Covers Tighten cap screws.</p> <p>D. Drain plug, Inspection plug, Oil filler plug Tighten plugs if loose. Replace plug if cracked. If gearcase is cracked, send car to shop for repairs.</p> <p>E. Oil filler elbow Tighten elbow if loose. Replace elbow if cracked.</p> <p>F. Bottom of gear case Bulges (internal damage), Dents (struck externally) Cracks. If gear case is damaged, send car to shop for repairs.</p>	
<div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>General Electric (Typical)</p> </div> <div style="text-align: center;">  <p>Westinghouse (Typical)</p> </div> </div> <p style="text-align: center;">Note: Breather should be kept clean, tight, and upright.</p> <p style="text-align: center;">FIGURE 1 TYPICAL GEAR CASES</p> <p>O. Overheating Any indication of overheating (blue color) especially in area of pinion should be reported to foreman.</p>		

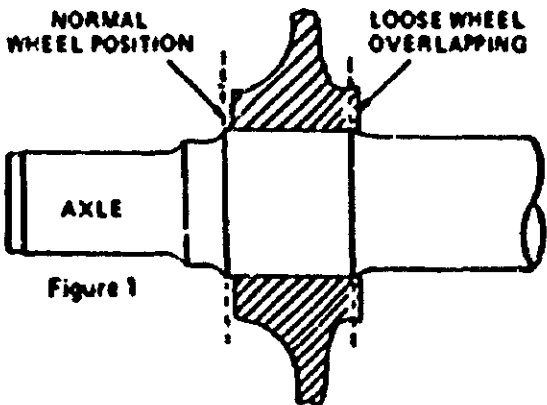
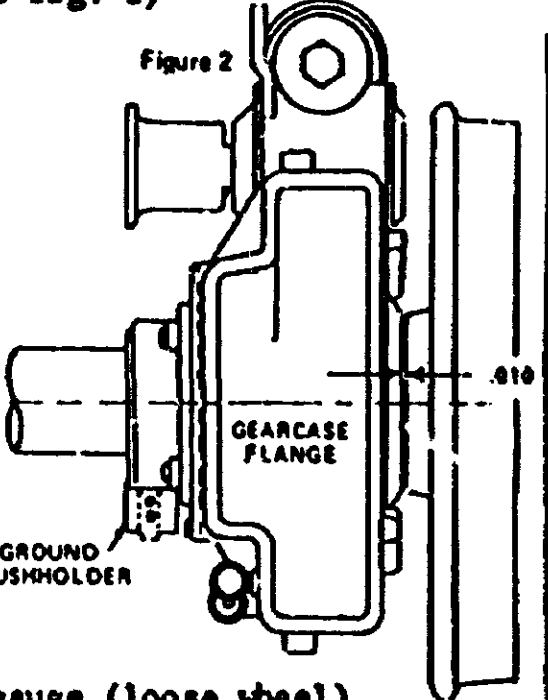
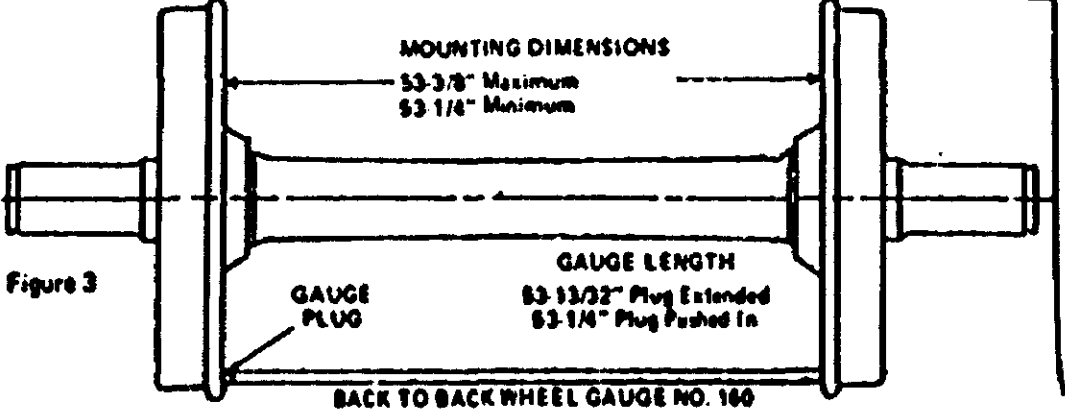
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NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
FOR R-10 TO R-44 CONTRACT CARS

OPER. NO.	DESCRIPTION	WM 7.5.0
7.5.2	<p>Examine high speed pinion bearing by pushing upward on Flexible Coupler and looking for movement between high speed pinion seal and bearing cap. If play is visually noticeable, report to foreman</p>  <p>FIGURE 2 PINION BEARING INSPECTION</p>	
7.5.3	<p>Inspect Gearcase Interior (See Figures 3,4,5) Clean the gearcase in the area of the inspection plug and oil filler plug before removing plugs.</p> <p>A. Remove Magnetic Inspection Plug and examine magnet for metal particles. If metal particles are found - report to foreman.</p> <p>B. Replace and tighten inspection plug. Secure with wire.</p>	

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NEW YORK CITY TRANSIT AUTHORITY
CARS & SHOPS TRUCK WORK MANUAL
FOR ALL CONTRACT CARS

OPER. NO.	DESCRIPTION	WM 7.6.0
.3	WHEEL AND AXLE INSPECTION	
	<p>Inspect axles (loose wheels)</p> <p>A. Indication of loose wheels</p> <ol style="list-style-type: none"> Oil or grease on back plate of wheel (seepage from bearing) Wheel over-lapping wheel seat (See figure 1) Space between wheel and gear case flange less than .010 (See fig. 2) 	
	<p>B. Measuring back to back wheel gauge (loose wheel)</p> <ol style="list-style-type: none"> If indication of loose wheel is found, use gauge No. 160 (back to back wheel gauge) to determine if wheels have moved. If gauge does not fit between wheels, or does not touch each wheel, <u>wheel movement is indicated</u>. Report to foreman. 	  
	<p>C. Inspect axles</p> <ol style="list-style-type: none"> Inspect axles for fatigue cracks or other defects. If cracks are found - report to foreman. 	<p>00194</p>

APPENDIX D

NEW YORK CITY TRANSIT AUTHORITY
ENGINEERING BULLETIN 709.1.A

NEW YORK CITY TRANSIT AUTHORITY — CAR MAINTENANCE DEPT.

MOTOR NOSE AND ANCHOR BOLTS --
R-10 TO R-46 CARS

ENGINEERING
BULLETIN 709.1.A

SHEET 1 OF 1

ENGRD J. ROSE W. A. HERNOS

APPVD E. H. Weidman

DATE December 28, 1977

1. On all main motors for the R-10 to R-46 cars, only the new type Motor Nose and Anchor Bolts will be used.

Motor Nose Bolts (3 required/motor) - 15-42-0237

Anchor Bolt (2 required/motor) ----- 15-42-0238

2. The old type bolts are not to be used and are to be removed from the shops and scrapped out as soon as feasible.

The new type bolts are identified by the markings on the head of the bolt. The markings may be as shown in fig. 1 or fig. 2 or fig. 3.

The head will also be marked with a symbol identifying the manufacturer.

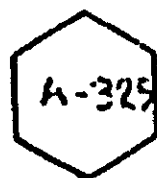


FIG. 1



FIG. 2



FIG. 3

3. Installation Torque:

These bolts are to be tightened to a torque of 400-450 foot - pounds on installation.

Redrawn with change

A Added description of head markings.
Added torque value.

J. L. Kelly 8-31-78

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25C/7, 1, 74

END
DATE
FILMED

10-28-82

NTIS